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ABSTRACT

This mathematical model is intended to be a tool for the monitoring of the bargaining process and to provide the ability to predict the form of bargaining outcomes given certain initial conditions. It applies to situations in organizations in which the conflict between the expressed desires of interest groups are settled by a bargaining process that is usually free but is at times subject to a higher authority. Central to the model is a temporal description of the paths leading to agreement. Also central is a characterization of the process by which bargaining units reach a final solution. The resulting model is intended to shed some light on the succession of changes in the weights that are placed by the bargaining parties on their respective goals. It deals with the dynamics of bargaining regardless of whether that bargaining is distributive, integrative, or intraorganizational. An example and analysis illustrate the functioning of the model. (Author/JM)

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A Model of a Dynamics of Bargaining

Presented at the

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by

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A Model of a Dynamics of Bargaining

In 1975 Canada led the world in days lost by labour due to strikes - a record not to sought after. Since Bill 100 has become law in Ontario the threat of strike on the part of the teaching profession has been constantly in the minds of those responsible for providing education for our society. Indeed the actual strike in its various forms, if not commonplace, has certainly become fact in many jurisdictions. These facts have led this author to commit considerable thought and energy toward developing a model that would provide a tool for the monitoring of the bargaining process and provide the ability to predict the form of the outcome, i.e. settlement or stalemate, given certain initial conditions.

The general aim of the work reported herein is to examine a class of situations arising in organizations in which the conflict between the expressed desires of various interest groups is permitted to be settled by a process of bargaining, which, while ordinarily free, is subject to pre-emption by some higher authority. Central to the accomplishment of the aim is the construction of a temporal description of paths leading to an agreement, and a characterization of the process by which the bargaining units reach a final solution within the set of feasible solutions. The content is a mathematical model of the dynamics or unfolding of bargaining processes that will shed some light on the succession of changes in the weights that are placed by the parties on their respective goals.

The concept denoted by "conflict" is too inclusive unless limited

by a clear description of the use to which the term will be put.

When desired goals are at least partially dependent on the actions of all parties, problems of coordination, co-operation, competition, conflict, and social influence become ubiquitous to social interactions. Seldom are the goals of interdependent parties perfectly coordinated. The degree of incompatibility of the goals of two or more parties defines the amount of conflict between them.

Boulding (1962, p.5) defined conflict "as a situation of competition in which parties are aware of the incompatibility of potential future positions and in which each party wishes to occupy a position that is incompatible with the wishes of the other(s)".

The potential for conflict is increased by two sets of environmental conditions:

a) when the parties involved want all or a large part of the available resources which are in short supply;

b) when the goal-directed behaviour of one party precludes the other party's goal attainment.

This work addresses a) above; it is felt b) is the proper domain of Psychology and Political Science. This shall not be construed to mean that b) can be ignored as one describes the dynamics of bargaining. However no attempt will be made here to consider 'behaviour' in the sense in which it is commonly used in Psychology.

This, 'conflict' will be considered to arise from "resource scarcity", that is, from situations in which the supply of desired objects (or states of affairs) is limited and, thus, the parties cannot have all they want. Conflict requires interaction among parties; it cannot exist without action. The action - reaction - action sequence arises through bargaining over incompatible goals

(Kerr (1954, 270) and Wright (1951, 198)). Given a conflict situation, it is possible (Schelling (1963)) to espouse two types of behaviour. The first deals with the psychological complexities of participants' behaviour, while the second focuses only on "rational" behaviour which is defined as

"conscious, intelligant, sophisticated conflict behaviour ... like a search for rules of 'correct behaviour' in a contest-winning sense" (p.3).

Such situations are those in which one participant depends on the choices or decisions of others in order to gain his own desires. Therefore, most conflict situations are essentially bargaining situations.

McGrath (1966, p. 101) defines the bargaining situation as one in which "representatives of two or more parties interact in an explicit attempt to reach a jointly acceptable position on one or more issues about which they are in disagreement". This leads to the possibility of developing the concepts of settlement, feasible solutions and stalemate, all three of which are essential elements of the dynamic bargaining model.

Walton and McKersie (1965) identified four types of bargaining: distributive, integrative, intraorganizational structuring, and attitudinal.

In distributive bargaining the basic conflict is due to a clash of goal preferences. Frequently this is a result of the environment being one that can be characterized as 'constant sum'.

Integrative bargaining takes place over mutual concerns and complementary interests and is best described as "variable sum' since cooperation can increase the total pay-off that may accrue to all parties.

Intraorganizational bargaining describes situations in which a representative of various groups within an organization sit together with a chief negotiator to bring about a settlement that is beneficial to the organization as a whole as well as, when possible, to each of the groups at the bargaining table.

Attitudinal structuring refers to the psychological aspects of bargaining; as such it does not belong to the scope of this work.

The first three of these four types of bargaining will be within the scope of this work. Therefore the work is concerned with groups who are bargaining with respect to a set of goals, at least some of which are held in common with varying degrees of preference. The groups are cohesive to the extent that they belong to a common organization or institution. The membership, as such, creates a degree of homogeneity that varies in intensity depending on the function of the group within the organization. An example of such a situation would be an educational system with its various units and teachers' federations, or a university with its various faculties, colleges, schools and centres of study.

The degree to which the above three types of bargaining may be distinguished and identified will depend on such factors as the ability of the parent organization to gain new resources. Where that ability is severely restrained the bargaining process is distributive in the whole. It may, however, be integrative (as far as a subset of the organizational groups are concerned) at the expense of all or some of the remaining groups within the organization. There is no doubt that the intraorganizational process is always present in the final act of bargaining although it may be of more or less importance depending on the success of free bargaining that has already taken place in

the earlier stages of the overall process.

In summary the model deals with the dynamics of the bargaining process regardless of which of the three types as defined by Walton and McKersie is taking place. That is, it investigates the free bargaining situation and, in so doing, it provides a tool for the analysis of restricted bargaining both in the intraorganizational and interorganizational sense, the latter being ones in which external arbitrators must intervene in order to bring about a settlement.

Bargaining is conceived as a means of dealing with complex interrelationships between management and the various subgroups and/or among the various subgroups as they interact with respect to their expressed desires, the alternative paths to their ends, and the usually fixed, or at best constrained resource endowment at the disposal of management.

The nature of the expressed desires is a key factor. Johnsen (1968) has amply demonstrated that corporate or institutional goals can be explicitly stated and that degrees of satisfaction of these goals created by various activities are measurable. It is assumed that each subunit within an organization can clearly enunciate its goals and that these are a subset of the corporate goals. When so doing the goals are such that they can be ordered with respect to preference of "utility". Considerable work has been carried out recently in the area of preference orderings for multi-attribute alternative. Humphreys and Humphreys (1975) and Tell (1976) have evaluated various methods by others such as Raiffa (1969), Keeney (1969), Miller (1970) and Tell (1974). As such they show the existance and applicability of the various methods.

By "expressed desires" it is understood that the goals are clearly enunciated.

There have been many models developed in the past that have been purported to represent bargaining or conflict resolution. They have ranged from the early economic model of Edgeworth (1881) through that of von Neuman and Morgenstern (1947) to Coddington (1968). All have made use of two basic concepts that have proved to be extremely restrictive. The first is that of a smooth continuous utility function. The second is that of rationality. Both of these concepts, although powerful in theory, tend to break down in practice.

This work does not assume either of the above. Indeed it is assumed that the parties to bargaining do not have a clearly defined utility curve but that they have discrete, discontinuous points to which they can attach a numerical weight which will indicate their preference for that particular position with respect to a number of goals.

The concept of rationality, that is if A is preferred to B and B to C thus A must be preferred to C is likewise not assumed. There has been considerable work done, usually in labratory settings, by such researchers as, Scodel (1959), Mmas (1960), Preston and Barrata (1968), Fouraker (1965), and Siegel (1960). These works bear out the doubtful validity of the hypothesis of 'rationality'. If it is accepted that such a doubt is reasonable, the least that can be said is that a bargaining theory that does not depend on the rationality assumption may produce a better model of the real world, in that it not only includes in its scope those that conform to 'rationality' but also those who deviate from it.

Most bargaining models to date have been cast in the two-party, single-objective setup, typical of the profit-oriented sector. Recent works have shown that the multi-objective situation is prevalent, especially in the non-profit sector (Johnsen 1968). Attempts have been made to reduce the multi-goal situation to a single-goal situation in order to enable the application of the earlier models based on the concept of a scalar-valued utility function. This was usually done by combining the multiple goals in some fashion to produce a single-valued scalar function, namely "utility function". However, to do so, may drastically distort reality resulting in a very limited use of the model. This is also true of the two-party versus the multi-party situation.

The general conclusion is that on account of either the initial assumptions or the mathematical techniques employed, the existing theories and their associated models may be of limited use.

The model presented here needs none of these severly restrictive assumptions. It is based on the premise that multi-objective, multi-group bargaining does indeed give an accurate reflection of reality and can be described with a relatively simple formal apparatus.

The Model

The following paradigm is the starting point for the development of the model.

Where x represents things and y represents purposes, one can discuss the utility of x for y to a person. The only category that has been recognized alike in the economists' utility functions and the decision analysts' utility functions is the x. y has not been recognized explicitly although it is clear that the shape of the two kinds of utility functions would depend on i) the components comprising y

ii) the degrees of importance assigned by an individual to the components of y.

In general the model is based on the assumption that each party i in the bargaining situation can place non-negative weights w_j^i on its various goals, such that $\sum_{j=1}^{n_i} w_j^i = 1$. Each party can measure the degree d_{kj}^i to which an act set A_k^i fulfills a $goal_j$, although such measure is subjective and can be communicated only by the group concerned.

When combined, the two measures, namely, the degree of fulfillment d_{kj}^i and the goal weight w_j^i give measures that permit the determination of the worth of the various act sets, A_k^i. This combination can be accomplished by a column multiplication of the d_{kj}^i's by the w_j^i's in the goal/act matrix as shown below.

	w_1^i	w_2^i - - -	w_j^i	- weight set
	G_1^i	G_2^i - - -	G_j^i	- goal set
A_1^i	$w_1^i d_{11}^i$	$w_2^i d_{12}^i$ - - -	$w_j^i d_{1j}^i$	
A_2^i	$w_1^i d_{21}^i$	$w_2^i d_{22}^i$ - - -	$w_j^i d_{2j}^i$	
act set				
A_k^i	$w_1^i d_{k1}^i$	$w_2^i d_{k2}^i$ - - -	$w_j^i d_{kj}^i$	

The bargaining unit, i, must then select the particular A_k^i that is optimum for its purposes. If the constraints are linear, this can be done in a number of ways, by parametric linear programming, by goal programming or by indifference combinations, to name but three. Once the appropriate A_k^i is identified, the various elements of the $w^i d^i$ vector are normalized such that $\sum_{j=1}^{n} w_j^i d_{kj}^i = 1$ for each i = 1,2, ... m and $o \leq w_1^i d_{kj}^i \leq 1$. A desired settlement or target vector is thus achieved and is entered as an input to the dynamics of bargaining.

The dynamic component of the model, contrary to those of others such as Coddington (1968), Cross (1969) and Bishop (1963) does not depend on the development of a smooth continuous function and differential equations. The changes in weights from one period to another are discrete and, on that account, are also abrupt and discontinuous. The goal weights are adjusted from period to period, by a simple process of comparison, resulting in a set of difference equations. The process of comparison is a behavioural hypothesis. The comparisons are two in number. The first is between one's own desired 'settlement state' and the prevailing state. The second is between each opponent's pre-bargaining state and his prevailing state. This results in a set of equations.

Where 1) $w_j^i(t+1)$ indicates the revised goal weight of party i on goal j at time t+1

and 2) $w_j^i(t)$ indicates the prevailing weight attached by i to his goal j at time t

and 3) u_j^i is an adjustment parameter based on party i's comparison of his own prevailing and desired settlement weights

and 4) w_j^{i*} is party i's desired settlement weight on goal j

and 5) u_j^k is an adjustment parameter based on the comparison of party k on goal j with his pre bargaining weight on goal j

and 6) $w_j^k(o)$ is party k's pre-bargaining weight on goal j

and 7) $w_j^k(t)$ is party k's prevailing weight on goal j at time t

then the adjustment process is defined as

$$w_j^i(t+1) = w_j^i(t) + u_j^i(w_j^{i*} - w_j^i(t)) + u_j^k(w_j^k(o) - w_j^k(t)) \quad .. \text{ E1.}$$

The variables appearing in E1 are either observable by or communicated to the analyst. In this sense E1 provides a means of monitoring the bid changes from period to period and describing the state of negotiations at any point in time. The difference $(w_j^{i*} - w_j^i(t))$ and $(w_j^k(o) - w_j^k(t))$ are permitted to range between an upper and lower tolerance level. When a particular w_j^i falls within the tolerance range it is said to be within bounds and no adjustment is made. i.e. $w_j^i(t+1) = w_j^i(t)$

The foregoing is a brief overview of the model which has been thoroughly analysed in all its complexities. It has been found to be Markovian in nature and thus settlement, feasible solutions and stalemate can be defined in the following way.

1. An exact settlement state is defined as being that state in which the number of goals within bounds is equal to mn, where m is the number of goals per participant, and n is the number of participants. Once the system arrives at the exact settlement state it will not leave that state. Thus the exact settlement state is a trapping or absorbing state in the Markovian sense.

2. A feasible solution state is defined as any state other than that with no goals within bounds.
3. A stalemate state is defined as.
   a) any state other than the mn'th state that is a trapping state, or
   b) any set of states not including the mn'th state that is periodic, or
   c) any state with a holding time greater than an arbitrary number of periods as set by the higher authority or by agreement amongst the participant.

The above definitions and the Markovian analysis permits answers to the following questions:

1. What is the probability a certain state such as the exact settlement state will be attained after t transitions with either full knowledge or no knowledge of the initial state?
2. How does the probability of the bargainer selecting a state depend on the number of periods and the initial state?
3. What can we say about the state of the process after t periods knowing the initial position?
4. What is the probability of a stalemate of each type?
5. How many states or transition periods must be gone through before a particular state is reached?
6. What is the probability that a particular state will have a holding time of x?

Answers to all or any of the above would be particularly useful to a mediator or an arbitrator in the prevailing environment in the field of Education in Ontario. Proper use of the information so provided would save considerable time and money for school boards

and teachers but even more importantly it would save much heartache and disturbance of the learning environment of our society with its concomittant increase in quality of education.

An Example

The model was tested in a laboratory setting. Two different hypothetical situations were set up. One involved two teams, one representing a Board of Education, the other the teachers' organizations within the employ of the Board.

The second situation involved three groups each representing a different faculty in the same university.

The following is a description of the latter case. Each faculty held five goals as follows:

1. To provide teaching at the undergraduate level to general students.
2. To provide teaching at the undergraduate level to honour students.
3. To provide teaching at the graduate level.
4. To carry out research.
5. To become involved in community work.

The corporate policy is that each faculty must hold all of the above goals to a greater or lesser extent within the limits as specified, i.e. no goal 1,2,3 or 5 may be weighted less than 10% unless that particular faculty does not offer programs in a specific area such as graduate work. Goals 1,2 and 3 combined may not be greater than 60%. Goal 4 may not be less than 30% or greater than 50%.

Faculty A analysed its resources and determined that they may be combined in four acceptable patterns or activity sets in order to meet its goals. It tentatively weighted the five goals as 0.25,

0.15, 0.1, 0.35 and 0.15 respectively.

The following activity/goal matrix resulted, each a^i_{kj} indicating the degree to which activity set A_k fulfills goal j

	G_1	G_2	G_3	G_4	G_5
A_1	.5	.3	.7	.6	.8
A_2	.4	.6	.3	.5	.7
A_3	.7	.4	.6	.3	.3
A_4	.6	.5	.5	.4	.2

When the a^i_{kj} entries are multiplied by the w^i_j or goal weight the following activity/goal weight matrix resulted.

	.25	.15	.1	.35	.15	$\Sigma w^i_j a^i_{kj}$
	G_1	G_2	G_3	G_4	G5	
A_1	.125	045	.07	.21	.12	.381
A_2	.1	.09	.03	.175	.105	.5
A_3	.175	.06	.06	.105	.045	.445
A_4	.15	.075	.05	.14	.03	.445

A number of criteria - and, hence, techniques - may be employed in selecting the activity set that would provide the greatest utility to A. In this case the group considered the sum of the row entries to give the best indication and so chose A_2. The $w^i_j a^i_{kj}$ values were then normalized (such that $\Sigma w^i_j a^i_{kj} = 1$). The resulting vector is (.2, .18, .06, .35, .21) and indicates the opening bids for Faculty A. In a like manner faculties B and C determined their opening bids to be (.35, .25, 0, .3, .1) and (.15, .15, .1, .5, .1) respectively.

Each bargaining unit (i.e. faculty in the example) approaches

the negotiation process with two sets of information, one that is common to all parties and the other that is unique to that specific unit. The common data is simply the final position of each faculty at the conclusion of the preceeding rounds of negotiation. In this case these were

A (.3, .1, .1, .4, .1)

B (.25, .3, .05, .35, .05)

c (.1, .2, .15, .45, .1)

The second set of data consist of

a) the goal weights at which each faculty hopes to settle

b) the tolerances around those weights as well as the tolerances around the weights of its opponents.

In this example these were

Faculty	Base Settlement Weights	Own Tolerances *		Opponents Tolerance	
		Upper	Lower	Upper	Lower
A	(.25, .15, .1, .35, .15)	10%	5%	3%	5%
B	(.3, .25, .1, .3, .05)	8%	4%	5%	10%
C	(.15, .15, .15, .35, 2)	12%	4%	4%	6%

* There is no need for these to be common for all goals or for all opponents. They were taken as such here for simplicity.

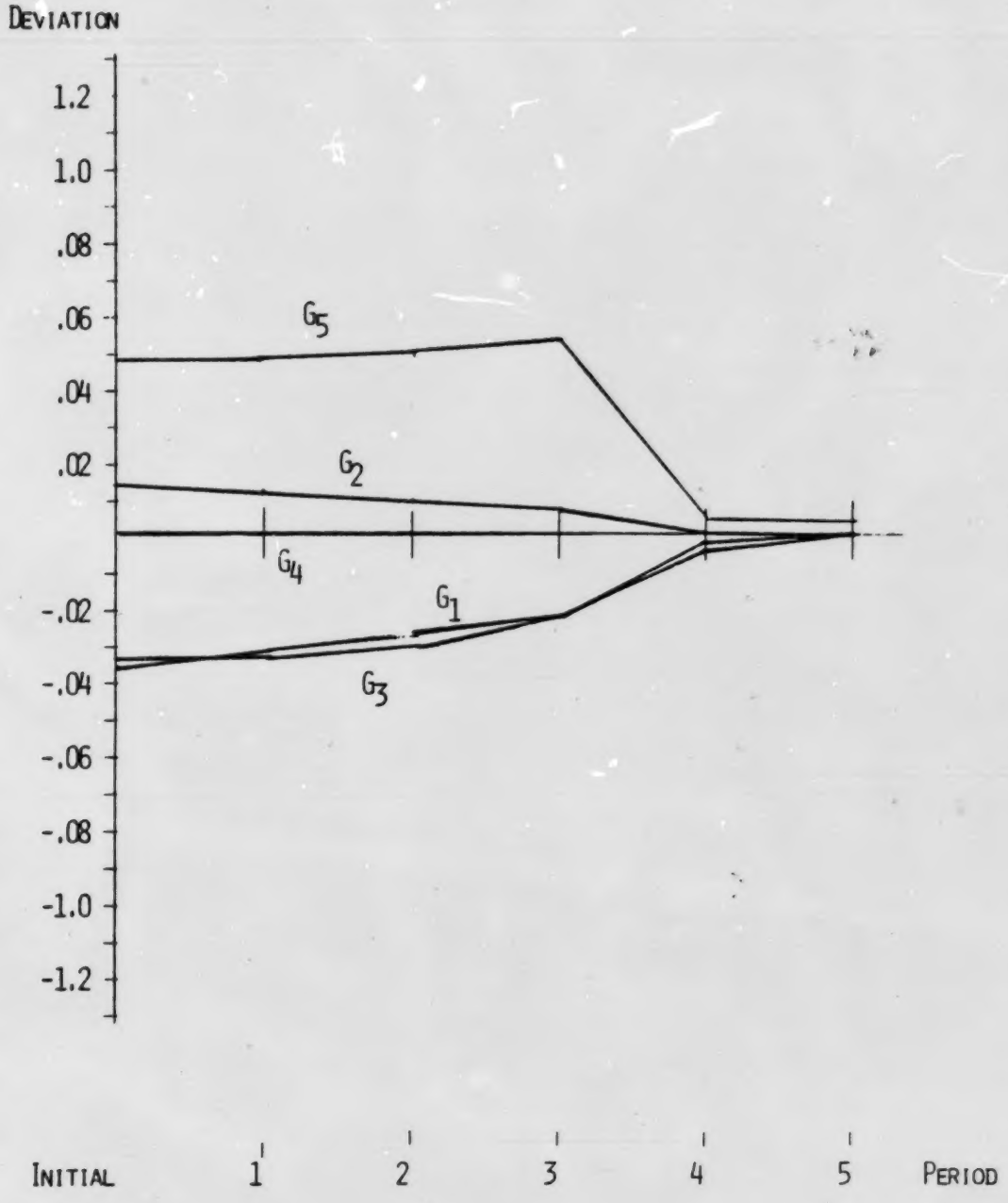
The number of rounds of negotiation was restricted to five. In other words, if a settlement was not established within five rounds the free bargaining would be interrupted and senior administration would arbitrate.

The adjustment parameters u_j^i & u_j^k that appear in E1 were designated by the parties at each round.

The following is the output of the model based on the above.

		Initial		Period 1		Period 2		Period 3		Period 4		Period 5	
Party	Goal	.Weight	.Dev.	.Weight	.Dev.	.Weight	.Dev.	.Weight	.Dev.	.Weight	.Dev.	.Weight	.Dev.
1	1	.2	-.038	.2036	-.034	.2086	-.029	.2129	-.025	.235	-.002	.2375	0
	2	.18	.015	.1781	.013	.1744	.009	.1713	.006	.165	0	.1451	0
	3	.06	-.035	.059	-.036	.0619	-.033	.0646	-.03	.0425	-.003	.0970	0
	4	.35	0	.3488	0	.3428	0	.3352	0	.3374	0	.3510	0
	5	.21	.045	.2102	.045	.2123	.047	.2160	.051	.1701	.005	.1693	.004
2	1	.35	.026	.3436	.02	.3379	.014	.3327	.009	.324	0	.324	0
	2	.25	0	.2567	0	.24	0	.2292	-.001	.1525	-.078	.228	-.002
	3	0	-.096	.0880	-.008	.0863	-.01	.0849	-.011	.0949	-.001	.096	0
	4	.3	0	.1973	-.091	.2086	-.079	.2145	-.074	.32	0	.288	0
	5	.1	.036	.1143	.05	.1271	.063	.1387	.075	.1086	.045	.064	0
3	1	.15	0	.1590	0	.1605	0	.1567	0	.1567	0	.1695	.001
	2	.15	0	.1332	-.011	.1393	-.005	.1450	0	.1174	-.027	.1284	-.016
	3	.1	-.044	.0998	-.044	.1039	-.040	.1077	-.036	.1440	0	.144	0
	4	.5	.108	.4870	.095	.4577	.066	.4368	.045	.392	0	.3642	0
	5	.1	-.094	.1211	-.073	.1386	-.055	.1538	-.04	.19	-.004	.194	0
# Goals Within Bounds			5		3		3		3		7		11

PARTY 1 DEVIATION MOTION



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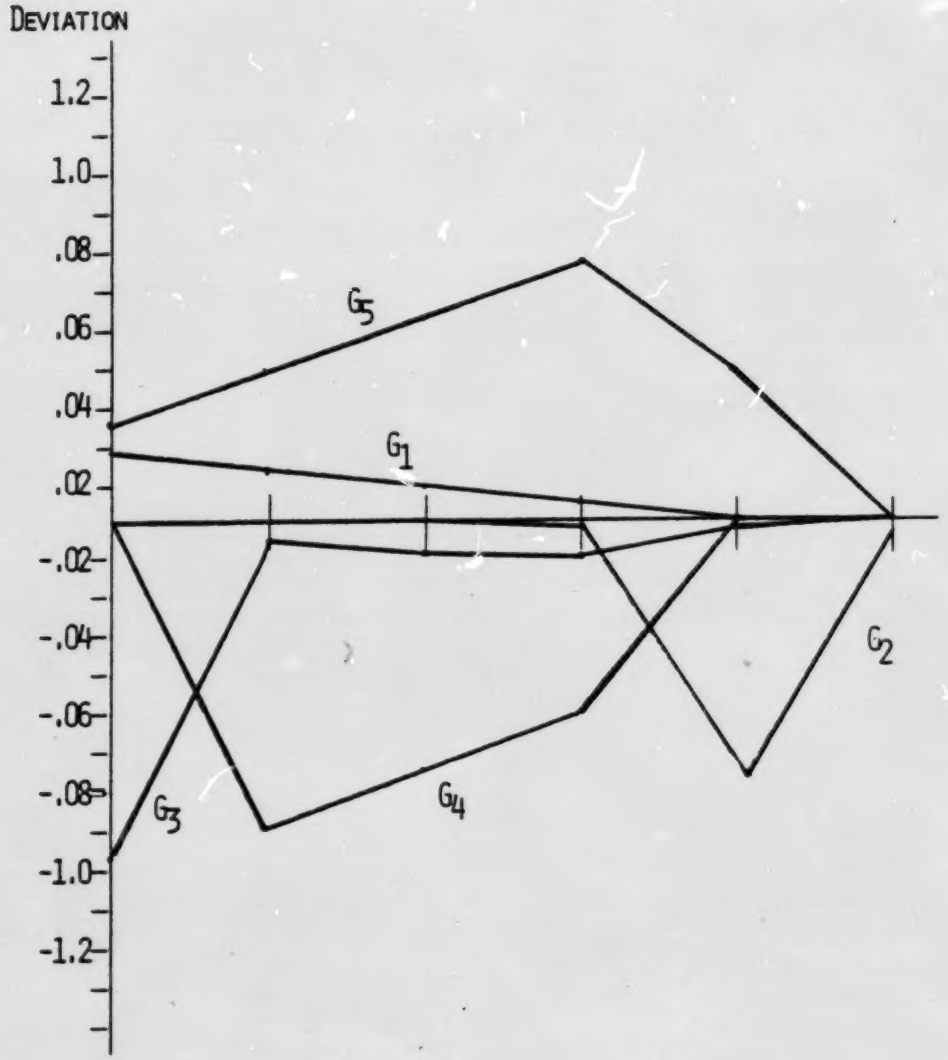
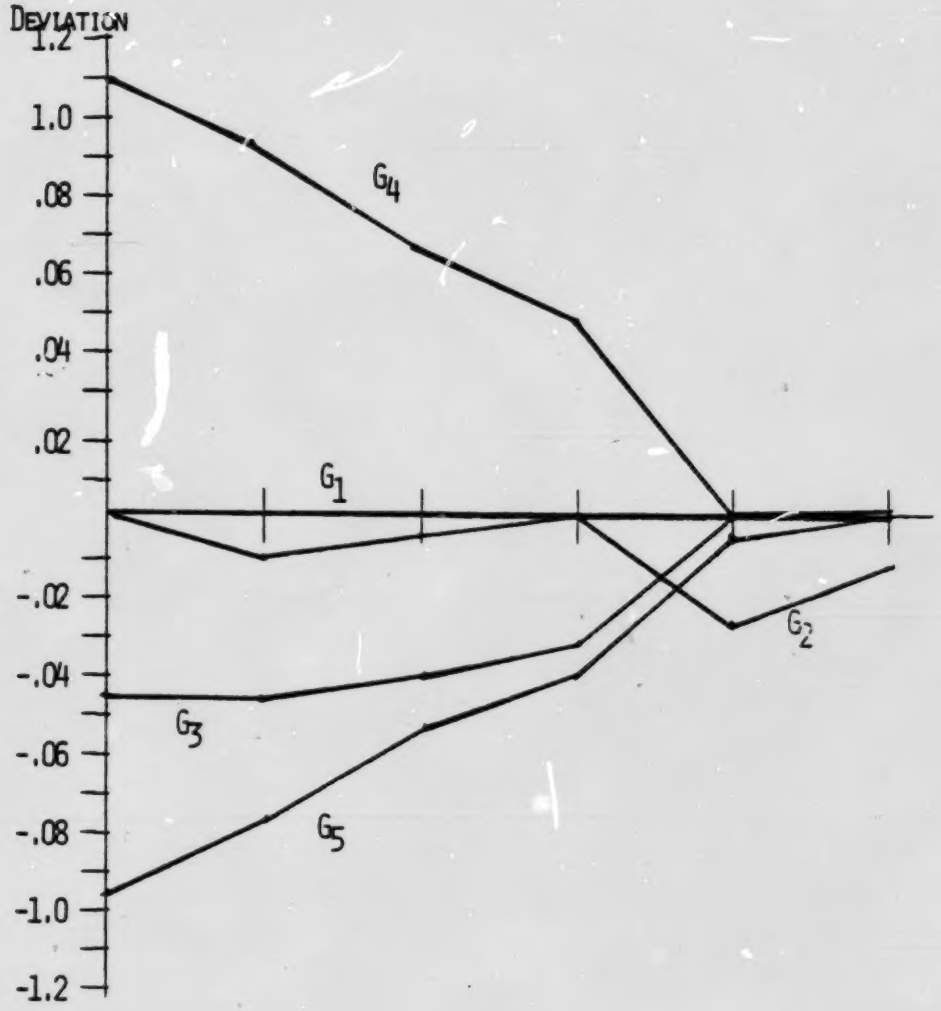


PARTY 3 DEVIATION MOTION



It is evident from the above data that the parties are closest to a settlement at the end of period 5. At this point goals 3 and 4 could be settled without further bargaining.

If a settlement is imposed it can be seen that faculty A would be within its tolerance levels on goals 1 to 4 and above its upper level by .004 on goal 5. Faculty B would be within its limits on goals 1,3,4, and 5 and below its lower level on goal 2 by .002. Faculty C is within the limits on goals 3,4 and 5, above its upper limit on goal 1 by .001 and below the lower limit on goal 2 by .016.

It is interesting to note that while faculty B and faculty C had goal 2 and goal 1 and 2 within the tolerance levels initially they were not so at the end of round 5.

The accompanying graphs depict the movement of the deviations toward the 0 level.

Whereas faculty A shows a consistent tendency to decrease the deviation from period to period on all goals, faculty B shows an eratic movement especially on goals 2 and 4. Faculty C shows a tendency to decrease the deviations on goals 3,4, and 5 and a slightly eratic movement in regard to goal 2.

This example and analysis illustrates the functioning of the model. The dynamics of the bargaining process is well portrayed as one considers the variation of the deviations.

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An Application in Public Education

Teacher - Board Negotiations.

In late November 1977 permission was granted to monitor the bargaining process between a Board of Education and one group of teachers in its employ. The following constraints were placed on the monitoring process:

1. Complete confidentiality must be maintained by the researcher.
2. The researcher must not become involved in the bargaining process in any way without the mutual consent of both parties.
3. Data gained and information developed by the researcher would be made available to a mediator or arbitrator in the event that such is assigned by the appropriate body only on the mutual consent of both parties.

It is evident that both the local teachers' federation group and the Board of Education were willing to co-operate in the research but were cautious with respect to the meaningfulness of any results.

By the time permission had been granted negotiations had been underway for some months. Initially fourteen items were under discussion. Many had been agreed upon early in the process and by late November three remained, namely, Salary (G_1); retirement gratuity (G_2); pupil/teacher ratio (G_3). As it turned out these proved to be too difficult to be resolved without assistance.

It is fortuitous that the circumstances provided a two party three goal process and thus the simulations being developed could provide a data base for comparative analysis.

Once permission was granted the researcher spent considerable time with each party separately, explaining the model and developing the concept of goal weights. It was agreed that, at this stage, the static phase (phase I) of the model, was not applicable. Therefore it was necessary to develop three sets of goal weights for both parties, namely, the pre-bargaining positions, the target settlement weights and the initial bids. Although each party was aware of its position on each of these in the traditional measurement mode (eg. dollars for salary, ratio for pupil/teacher ratio and dollars for retirement gratuity,) neither party was accustomed to thinking of them in terms of a common weight. The teachers' group found less difficulty with the concept and were relatively quickly able to develop a variety of possible goal weight vectors.

The Board of Education bargaining team, comprised mainly of farmers and small businessmen, were able to cope with the concept (understood as percentages) and finally developed the appropriate vectors. (see Table 5.1 for the initial conditions)

Historical records were available with respect to previous negotiations. These were not in a form that could be readily fed into the model, it was possible to estimate reaction parameter levels from the records from discussion with the members of the negotiation teams, many of whom had two or more years of experience in the position in that county. In fact the mean number of years experience in negotiating in that system was 4.2 for the teachers and 4.7 for the board members.

In the past, relations between the two groups were amicable. Both groups, separately, identified that the 3.1 parameter combination was the most appropriate description of the adjustment process in the previous years. However, it appeared that the relationships had altered over the past few months and both, again separately, identified the 2.2 parameter combination as the most likely for the immediate future negotiations. [1.]

1.

3.1 indicates a medium self adjustment parameter and a zero opponent adjustment parameter.

2.2 indicates a high adjustment parameter on both the self and the opponent portion.

Initial Conditions

		Teachers	Board
Pre-Bargaining	G_1	.30	.47
	G_2	.38	.25
	G_3	.32	.28
Base Settlement	G_1	.35	.55
	G_2	.28	.20
	G_3	.37	.25
Alpha	G_1	.04	.02
	G_2	.04	.02
	G_3	.04	.02
Beta	G_1	0	0
	G_2	0	0
	G_3	0	0
Delta	G_1	0	0
	G_2	0	0
	G_3	0	0
Gamma	G_1	.02	.03
	G_2	.02	.03
	G_3	.02	.03
Opening Bid	G_1	.30	.63
	G_2	.17	.15
	G_3	.53	.22

Table 5.1

The initial conditions as shown above illustrate the basic differences in the two parties as well as one identical position. The teachers indicated a weighting from the previous settlement as approximately equal across the three goals in question whereas the trustees considered the weightings to be about 2:1:1. The teachers hoped to maintain the 1:1:1 weighting with minor shifts from the retirement gratuity in favour of both salary and pupil/teacher ratio. The trustees wished to place less emphasis on the retirement gratuity

and much more on salary with only a minor shift on pupil/teacher ratio. The many plausible reasons for the Boards' position, such as an election year, will not be discussed.

Previous months of negotiating over other items, now settled, lead the teachers to opening bids at the November date that would be considered extreme in at least one area, that of, the pupil/teacher ratio weight. All others, although outside the tolerance band, could be considered to be within the realm of negotiability.

The data so obtained was used as the basis for a one hundred round simultation. Figure 5.1 gives the plot of the 100 round simulation.

Table 5.2 gives the number of goals within bounds as provided by the simultation.

Table 5.3 gives the number of goals within bounds as provided by direct observation of the process. The weights were established by the researcher in discussion with the chief negotiator for each team as quickly following the negotiating round as possible. In most instances this was the following day for at least one party. It must be emphasized that these are entirely subjective

Number of Goals Within Bounds at the End of Each Round
(Simulated Data)

Round									
1	2	3	4	5	6	7	8	9	10
3	0	0	1	1	1	0	1	0	2
1	2	1	1	1	1	1	2	1	1
1	2	1	1	1	2	1	1	1	2
1	1	1	2	1	1	1	2	1	1
1	2	1	1	1	2	1	1	1	2
1	1	1	2	1	1	1	2	1	1
1	2	1	1	1	2	1	1	1	2
1	1	1	2	1	1	1	2	1	1
1	2	1	1	1	2	1	1	1	2
1	1	1	2	1	1	1	2	1	1

Table 5.2

Number of Goals Within Bounds at the End of Each Round
(Observed Data)

Round									
1	2	3	4	5	6	7	8	9	10
3	0	1	1	1	1	0	1	0	2
0	2	0	1	0	1	0	2	0	1
0									

Table 5.3

and may be influenced by many factors, not the least of which is that the researcher had knowledge of the simulated data at that time.

Table 5.3 concludes at period 21 as it was at this point that a mediator was appointed.

A t-test for paired data was performed to test the hypothesis that there was no difference in the two series at the 95% level of significance.

The hypothesis was upheld as the t-statistic was .56 which falls within $\pm$ 2.086 for 20 degrees of freedom.

The simulated data shows a cyclic pattern beginning at period 18. The parties, had they known this, and accepted it, could have either altered the approach to negotiations or opted for a mediator early in the process. According to the initial agreement no such information was given to either side. It is interesting to note that a stalemate was recognized at the end of period 21 after 6 weeks of negotiations and after a lengthy period of time both parties agreed to accept a mediator. They also gave permission, after examining the data that it would be provided to the mediator.

Although it appears as though they were closest to a settlement at round 1 they were not because the three goals within bounds did not include any in which both parties were within bounds on the same goal. At the end of round 10 this was the case. Both parties were within bounds on the retirement gratuity goal, however, one of the parties, the teachers, refused to settle on that goal until the others were also settled.

The mediator selected this point as his opening. The goal weights were:

Teachers (.44, .28, .28)

Board (.62, .22, .16)

The impasse was resolved within five hours of mediated negotiations with the settlement vectors being:

Teachers (.37, .28, .35)

Board (.55, .22, .23)

It is evident from this application that the model, at least in this case, was able to provide a fairly accurate description of the process. Thus it can be concluded that adjustment parameters such as u_j^i and u_j^k do exist.

There still remains the overriding question of practical usefulness of the model. In spite of the limited measure of success reported above there will be an unavoidable element of subjective judgment in the assessment of applicability in the general situation.

In this particular case both parties and the mediator felt it had been of use as it served to focus attention on the specific goals and their Inter-relationships.

The mediator was cautiously enthusiastic as it did indeed give him a clear picture of the results of the previous rounds of negotiation and it provided him with a point from which he could begin his task of bringing the parties to an acceptable solution.